

American National Standard

**unrecorded magnetic tape
for information interchange
(9-track 200 and 800 CPI, NRZI,
and 1600 CPI, PE)**



american national standards institute, inc.
1430 broadway, new york, new york 10018

**American National Standard
Unrecorded Magnetic Tape
for Information Interchange
(9-Track 200 and 800 CPI, NRZI,
and 1600 CPI, PE)**

Secretariat

Computer and Business Equipment Manufacturers Association

Approved February 3, 1976

American National Standards Institute, Inc

American National Standard

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Foreword

(This Foreword is not a part of American National Standard Unrecorded Magnetic Tape for Information Interchange (9-Track 200 and 800 CPI, NRZI, and 1600 CPI, PE), X3.40-1976.)

This standard, which is a revision of American National Standard X3.40-1973, presents the minimum requirements for the physical and magnetic interchangeability of 1/2-inch-wide magnetic tape and reels to be used for information processing systems, communication systems, and associated equipment utilizing the American National Standard Code for Information Interchange, X3.4-1968 (ASCII). This standard deals solely with magnetic tape for digital recording and supports and complements related American National Standards on recorded magnetic tape for information interchange, for recording at 200 and 800 characters per inch (CPI) using nonreturn-to-zero — change on ones (NRZI) recording techniques, and at 1600 characters per inch using phase-encoded (PE) recording techniques.

The X3B1/EIA P8.6 Ad Hoc Group, which developed this standard, consists of a number of experienced and qualified specialists on recording of digital information on magnetic tape. In the development of this standard careful consideration was given to current practices, existing equipment and supplies, and the broadest possible acceptance, and to providing a basis for future improvement in the use of the medium.

This standard was approved as an American National Standard by ANSI on February 3, 1976.

Suggestions for improvement of this standard will be welcome. They should be sent to the American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.

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American National Standard Unrecorded Magnetic Tape for Information Interchange (9-Track 200 and 800 CPI, NRZI, and 1600 CPI, PE)

1. Scope and Purpose

1.1 Scope. This standard provides specifications for 1/2-inch-wide unrecorded magnetic tape and reels to enable mechanical and magnetic interchangeability of tape between information processing systems, communication systems, and associated equipment utilizing the American National Standard Code for Information Interchange, X3.4-1968 (ASCII). This standard deals solely with magnetic tape for digital recording and supports and complements American National Standards on recorded magnetic tape for information interchange, namely: American National Standard Recorded Magnetic Tape for Information Interchange (200 CPI, NRZI), X3.14-1973; American National Standard Recorded Magnetic Tape for Information Interchange (800 CPI, NRZI), X3.22-1973; and American National Standard Recorded Magnetic Tape for Information Interchange (1600 CPI, PE), X3.39-1973.

CAUTION NOTICE: The user's attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights.

By publication of this standard, no position is taken with respect to the validity of this claim or of any patent rights in connection therewith. The patent holder has, however, filed a statement of willingness to grant a license under these rights on reasonable and nondiscriminatory terms and conditions to applicants desiring to obtain such a license. Details may be obtained from the publisher.

No representation or warranty is made or implied that this is the only license that may be required to avoid infringement in the use of this standard.

1.2 Purpose. The purpose of this standard is to provide the minimum requirements for data interchange, including the use of end-of-life tape; it is not intended to serve as a criterion specifically for the certification of new tapes.

2. Definitions

Amplitude Reference Tape. The tape used to establish the Standard Reference Amplitude when it is recorded

with continuous ones at the density under consideration (NBS Amplitude Reference Tape-SRM 3200).

back surface. The surface of the tape opposite the magnetic coating.

beginning-of-tape (BOT) marker. A photoreflective marker placed on the tape for the purpose of indicating the beginning of the recording area.

density. The nominal distribution per unit length of recorded information; usually expressed in characters per inch.

end-of-tape (EOT) marker. A photoreflective marker placed on the tape for the purpose of indicating the end of the recording area.

skew. The deviation of bits within a character from the intended or ideal placement, which is perpendicular to the reference edge.

Standard Measurement Current. For the Amplitude Reference Tape, the relationship between the Standard Measurement Current (I_m) and the Standard Reference Current (I_r) at the various recording densities, in flux reversals per inch (frpi), shall be as given in the following table:

Recording Density (frpi)	Ratio $n = \frac{I_m}{I_r}$
200	2.0 to 2.2
800	2.0 to 2.2
3200	1.75 to 1.85

Standard Reference Amplitude. The average peak-to-peak output signal amplitude derived from the Amplitude Reference Tape when it is recorded at the Standard Measurement Current on the NBS measurement system at the density under consideration.

Standard Reference Current. For any specified recording density, the Standard Reference Current (I_r) is the minimum current applied to the Amplitude Reference

Tape that causes an output signal amplitude equal to 95% of the maximum output signal.

3. General Requirements

3.1 Material. The tape shall consist of a base material (oriented polyethylene terephthalate film or its equivalent), coated on one side with a strong, yet flexible, layer of ferromagnetic material dispersed in a suitable binder. The back surface shall be of a nonmagnetic nature and shall be equivalent to polyethylene terephthalate in performance.

3.2 Operation, Storage, and Test Environments

3.2.1 Operation. The operation temperature shall be within the range 60°F to 90°F, and the relative humidity 20% to 80%. The wet-bulb reading shall not exceed 78°F.

3.2.2 Storage

3.2.2.1 Unrecorded Tape. The storage temperature shall be within the range 40°F to 120°F, and the relative humidity 20% to 80%. The wet-bulb reading shall not exceed 80°F.

3.2.2.2 Recorded Tape. The storage environment shall be the same as for unrecorded tape except that the maximum storage temperature is 90°F. If this temperature is exceeded, performance may be affected.

3.2.3 Test. Unless otherwise stated, all measurements shall be performed under the following ambient conditions after the tape to be tested has been subjected to these conditions for at least 24 hours: temperature 73°F ± 5°F; relative humidity 50% ± 10%.

3.3 Control Devices and Attachments

3.3.1 Photoreflective Markers. Each reel of tape shall be furnished with two reflective markers, consisting of (or equivalent to) a transparent plastic base with a vaporized aluminum coating sandwiched between the base and a thin layer of low-cold-flow adhesive. Dimensions and placement of the reflective markers shall be as shown in Fig. 1.

3.3.2 Marker Reflectivity

3.3.2.1 Definition. The percent reflectivity possessed by a reflective photosense marker, compared to a reference standard, over an angle of incidence of light of 60 degrees.

3.3.2.2 Requirement. The photoreflective marker shall have at least 90% of the reflectivity of the standard.

3.3.2.3 Procedure

3.3.2.3.1 Provide a reflectivity standard of 6061-T6 aluminum with a flat-face dimension of 1.1 inches ± 0.2 inch by 0.19 inch ± 0.02 inch with a surface finish of between 0.3 and 0.6 μin (microinches),

with the centerline average (CLA) reading taken. Resurface the standard periodically to prevent a reflectivity shift due to oxidation. The light source and detection system should be capable of testing the complete range from 16 to 59 μin. The receptor should have a flat surface and be larger than any mask orifice used.

3.3.2.3.2 Provide a fixture that will seat the reflectivity standard and the marker under test in the same plane. Care should be taken to make sure that ambient light does not enter the measuring photocell.

3.3.2.3.3 Measure and note the reflectivity of the standard.

3.3.2.3.4 Measure and note the reflectivity of the marker under test.

3.3.2.3.5 Compare the marker reflectivity (expressed in percent) to the reflectivity of the standard.

3.3.3 Leaders and Trailers. Special leaders and trailers may be attached to the tape provided they cause no functional problem from embossing or in loading or unloading. Splices, however, are not allowed.

3.4 Tape Wind. Tape shall be wound in a clockwise direction with the oxide surface toward the reel hub; that is, when the reel is viewed from the front, the loose end of the tape hangs from the right side of the reel. Tape shall be wound with a tension of 5 to 10 ounces.

4. Tape Physical Requirements

4.1 Dimensions

4.1.1 Tape Width. The tape width shall be 0.498 inch ± 0.002 inch.

4.1.2 Tape Thickness

4.1.2.1 Definition. The tape thickness is defined as the sum thickness of all components of the magnetic tape.

4.1.2.2 Requirement. The tape thickness shall be 0.0019 inch ± 0.0003 inch.

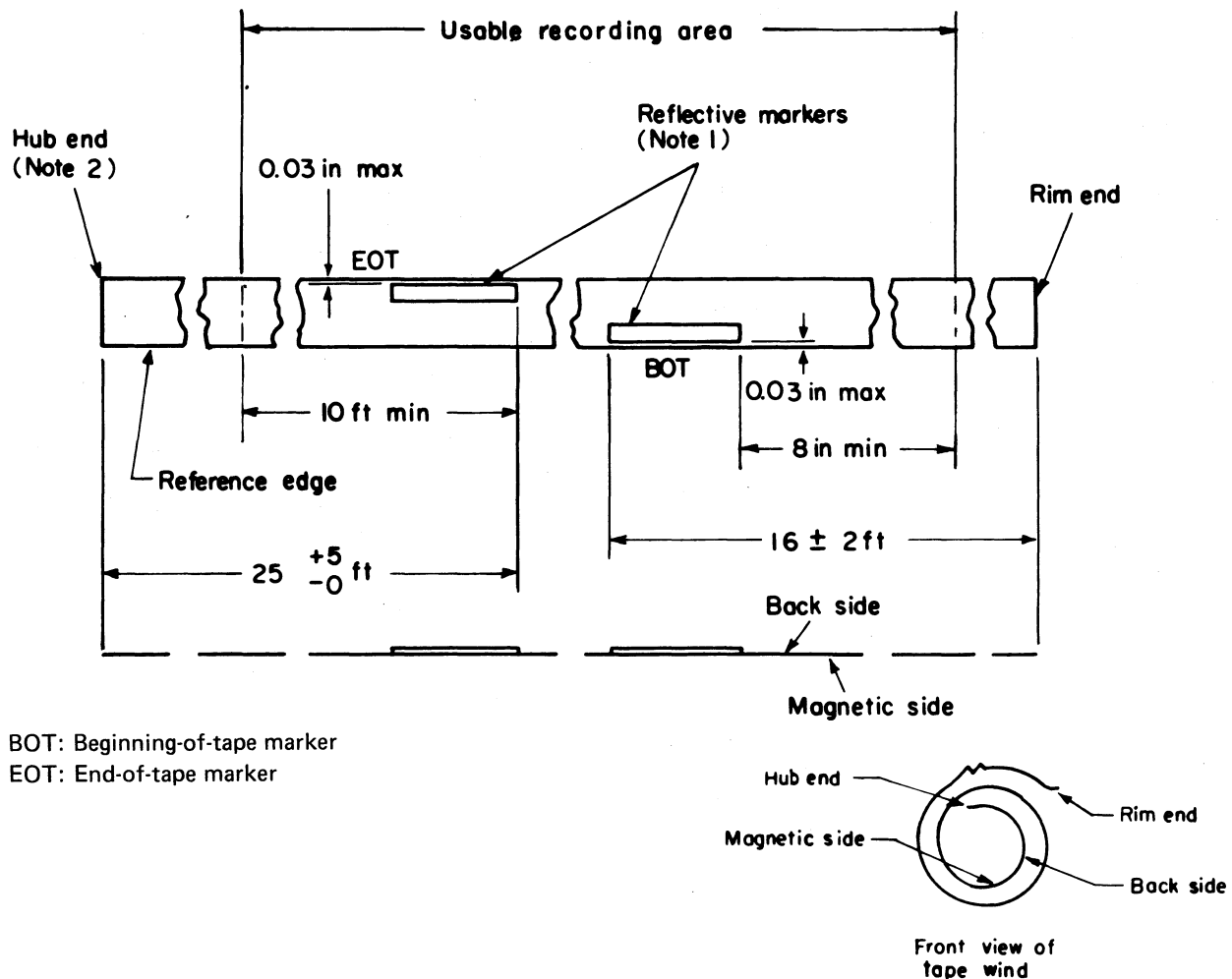
4.1.3 Base-Material Thickness. The base-material thickness shall be 0.00142 inch nominal.

4.1.4 Oxide Coating Thickness. The coating thickness shall be 0.0006 inch maximum.

4.1.5 Tape Length. Tape length shall be agreed upon by the interchange parties. The maximum length shall be limited by requirements given in this standard for reel dimensions, tape thickness, "E" value, and moment of inertia.

4.2 "E" Value

4.2.1 Definition. The "E" value is defined as the radial distance by which the edge of the reel flange extends beyond the outside layer of tape.



NOTES:

(1) Photoreflexive markers shall not protrude beyond the edge of the tape and shall be free of wrinkles and excessive adhesive. Marker dimensions: length, 1.1 inches $\pm$ 0.2 inch; width, 0.19 inch $\pm$ 0.02 inch; thickness, 0.0008 inch maximum.

(2) Tape shall not be attached to the hub.

Fig. 1
Usable Recording Area

4.2.2 Requirement. The minimum value shall be 1/8 inch.

4.2.3 Procedure. The tape shall be wound at a tension of 5 to 10 ounces on the specified reel.

4.3 Tensile Yield Force

4.3.1 Definition. The tensile yield force shall be taken as the force required to elongate the sample 3%.

4.3.2 Requirement. The tensile yield force at 3% elongation shall be a minimum of 7 pounds.

4.3.3 Procedure. Use a static-weighting-constant-rate-of-grip separation tester capable of indicating the load to an accuracy of $\pm$ 2%. Clamp a specimen of tape at least 7 inches in length with an initial 4-inch separation be-

tween the jaws. Elongate the specimen at a rate of 2 inches per minute until a minimum elongation of 10% is reached. The force required to produce an elongation of 3% is the tensile yield force.

4.4 Tape Integrity Failure

4.4.1 Definition. A cohesive or adhesive failure.

4.4.2 Requirement. There shall be no tape integrity failure.

4.4.3 Procedure. The tape sample shall be recorded with continuous ones on all tracks at 200 or 800 CPI at the Standard Measurement Current. It shall be rewound and read back, noting all bits (if any) that do not reproduce at an output level of at least 30% of the Standard

Reference Amplitude. The tape shall then be wound on a reel that conforms to the specifications of Section 6, at a tension of 5 to 10 ounces. Store at 120°F and a relative humidity of 50% for 40 hours. Recondition by storing at operating ambient conditions (see 3.2.3) for 24 hours. Read back the tape and note whether any additional defects have occurred. If so, examine the defective areas and determine whether a tape integrity failure has occurred.

4.5 Dynamic Frictional Characteristics

4.5.1 Oxide Coating to Brass and Chrome

4.5.1.1 Definition. The resistance of the tape oxide coating to motion on brass (chrome).

4.5.1.2 Requirement. The dynamic frictional drag shall be a maximum of 130 grams.

4.5.1.3 Procedure. At 2 inches per minute, pull the sample up over a 1-inch-diameter brass (chrome) cylinder (90-degree wrap) with a 65-gram weight on the other end of the tape. Plot force versus time (or force versus distance) on a recorder. Particular attention should be given to keeping the samples clean and maintaining the brass (chrome) cylinder finish (5–10 μ in peak-to-peak).

4.5.2 Oxide Coating to Back Surface

4.5.2.1 Definition. The resistance of the tape oxide coating to motion on the back surface.

4.5.2.2 Requirement. The dynamic frictional drag shall be a minimum of 80 grams.

4.5.2.3 Procedure. At 2 inches per minute, pull the oxide-coated surface of the sample up over a 1-inch-diameter cylinder (90-degree wrap) covered with one layer of tape, back surface up. Suspend a 65-gram weight on the free end of the tape. Plot force versus time (or force versus distance) on a recorder.

4.5.3 Tape Back Surface to Stainless Steel

4.5.3.1 Definition. The resistance of the tape back surface to motion on stainless steel.

4.5.3.2 Requirement. The dynamic frictional drag shall be a maximum of 85 grams.

4.5.3.3 Procedure. At 2 inches per minute, pull the sample up over a 1-inch-diameter stainless steel cylinder (90-degree wrap) with a 65-gram weight on the other end of the tape. Plot force versus time (or force versus distance) on a recorder. Particular attention should be given to keeping the samples clean and maintaining the stainless steel cylinder finish (5–10 μ in peak-to-peak).

4.5.4 Rubber to Tape Back Surface

4.5.4.1 Definition. The resistance of the tape back surface to motion on rubber.

4.5.4.2 Requirement. The dynamic frictional drag shall be a minimum of 80 grams.

4.5.4.3 Procedure. At 2 inches per minute, pull

the sample up over a rubber-coated cylinder (90-degree wrap) with a 65-gram weight on the other end of the tape.

Cylinder construction shall consist of a stainless steel inner cylinder 1.020 inches $\pm$ 0.005 inch in diameter by 0.730 inch $\pm$ 0.005 inch (a center bore convenient for mounting is optional) to which a 0.204-inch $\pm$ 0.005-inch coating of rubber is vulcanized. This rubber shall be Ames Rubber Company material ARX2487B (or the equivalent) Shore A; Durometer 78, + 0, – 7; color, black.

Plot force versus time (or force versus distance) on a recorder.

4.6 Cupping

4.6.1 Definition. The departure across the width of tape from a flat surface.

4.6.2 Requirement. The maximum cupping of a 1/4-inch length of tape shall not exceed 0.010 inch when placed concave side down on a smooth, level surface.

4.7 Residual Elongation

4.7.1 Definition. A time-dependent strain that results from the application of a constant stress.

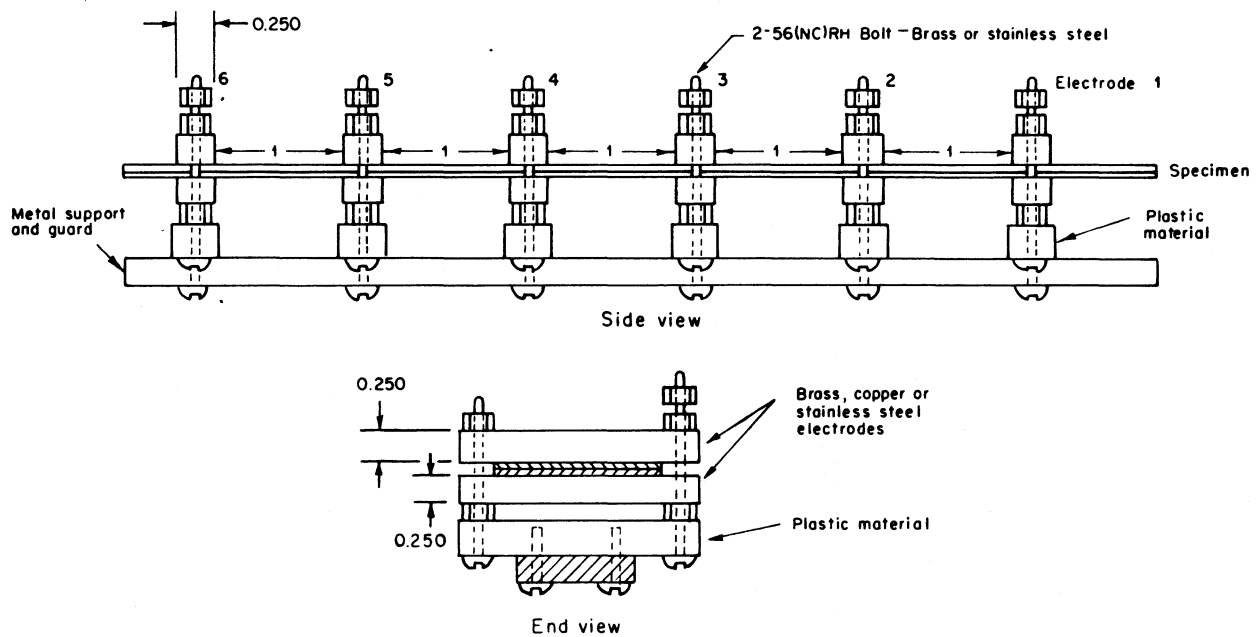
4.7.2 Requirement. The residual elongation shall be less than 0.5%.

4.7.3 Procedure. The apparatus for this test shall consist of positive nonslipping clamping devices, a 100-gram weight, and a 5-pound weight. Samples at least 28 inches long shall be clamped and hung in the test area for at least 24 hours with no external stress applied.

Before any weight is hung on the samples, make a mark approximately 20 inches from the point of clamping. Attach the 100-gram weight to the free end of the tape and measure the distance between the mark and the clamping point to the nearest 0.01 inch. This distance shall be taken as the base distance for calculation of residual elongation. When the measurement of the base distance has been made, the test shall begin. Remove the 100-gram weight and attach the 5-pound weight. In this condition, allow the sample to hang undisturbed for 180 minutes $\pm$ 30 seconds. Remove the 5-pound weight. The tape shall be allowed to hang for an additional 180 minutes $\pm$ 30 seconds. Attach the 100-gram weight and measure the distance between the mark and the point of clamping to the nearest 0.01 inch. The difference between the base distance and the final distance shall be expressed as a percent of the base distance to determine compliance with the requirement.

4.8 Curvature

4.8.1 Definition. A departure from a straight line of the longitudinal dimension of the tape in the plane of the surface of the tape.



NOTE: All dimensions are given in inches.

Fig. 2
Applications of Strip Electrodes to Magnetic Tape Specimens

4.8.2 Requirement. Any deviation from a straight line shall be gradual and shall not exceed 1/8 inch per 36-inch length of tape.

4.8.3 Procedure. Allow a 36-inch length of tape to assume its natural curvature on a flat, smooth surface. Measure the maximum deviation of the concave edge of the tape from a straight line.

4.9 Skew

4.9.1 Definition. The dynamic skew as measured between the recorded peaks of "1" bits in the two outside tracks of the same character.

4.9.2 Requirement. The dynamic skew shall not exceed 2.0 μ s (microseconds) at 112-1/2 inches per second continuous tape speed.

4.9.3 Procedure. Continuous strings of all-ones character shall be written by a properly adjusted 729VI (or equivalent) tape transport for the entire recoverable length of the tested tape. During write verify or a subsequent read, the time difference shall be dynamically measured between amplitude peaks of the outside bits in each character. An accurate peak detector shall be used. The greatest allowable time difference for any of the characters measured shall not exceed the foregoing specification.

4.10 Electrical Resistance

4.10.1 Definition. Ohms per square of the magnetic surface.

4.10.2 Requirement. The resistance shall not exceed 5×10^8 ohms per square, but shall be greater than 5×10^5 ohms per square.

4.10.3 Procedure. After 12 hours of exposure to the test environment, two layers of the sample tape shall be placed back to back between the strip electrodes as shown in Fig. 2 and 3, such that the magnetic-oxide-coated sides are in contact with all of the electrodes. In mounting the specimen for measurement, it is important that no conducting paths exist between the electrodes except those through the specimen. To ensure that the length of tape held between each strip electrode is the same, the specimen shall be placed under a tension of 8 ounces $\pm$ 2 ounces as it is being clamped.

NOTE: Neither the specimen nor the insulating surfaces shall be handled with bare fingers. The use of clean, lint-free gloves is recommended.

Measurements shall be made between each pair of adjacent electrodes. This will produce a total of five readings per specimen. The resistance of the coating shall be determined using a guarded circuit, as shown in Fig. 3, using a potential of 100 or 500 volts $\pm$ 10 volts. Average the five resistance readings.

4.11 Moment of Inertia (Full Reel)

4.11.1 Definition. A characteristic that indicates the ability of a reel of tape to be accelerated about

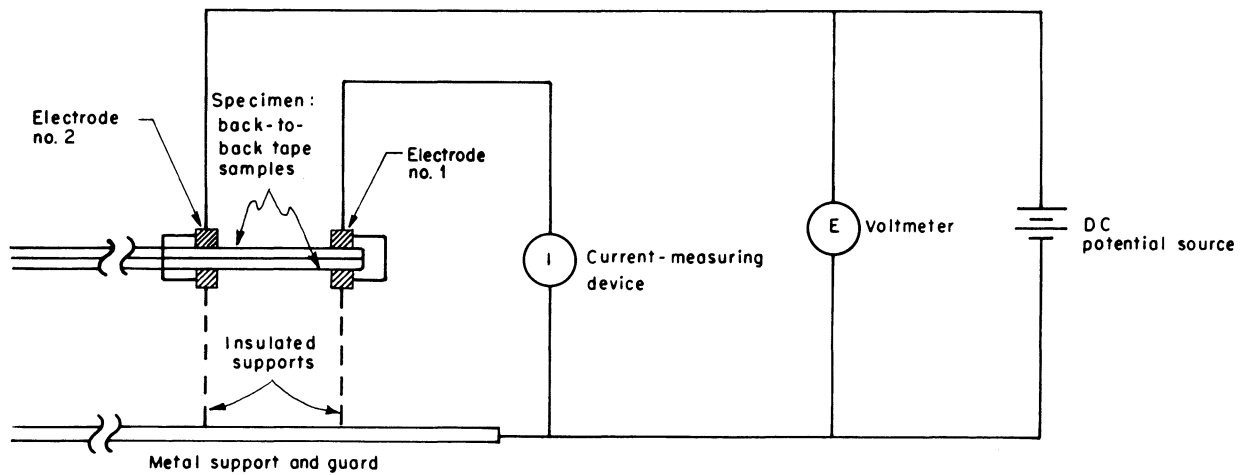


Fig. 3
Circuit for Measuring Specimen Resistance

its normal axis of rotation.

4.11.2 Requirement. The moment of inertia for a reel of tape shall not exceed $0.091 \text{ in} \cdot \text{lb} \cdot \text{s}^2$.

4.11.3 Procedure

4.11.3.1 Weigh full reel including the write-enable ring.

4.11.3.2 Place the reel squarely on a knife-edge pivot. Deflect the reel through a maximum angle of 10 degrees and then release it so that it begins to oscillate about the knife edge.

4.11.3.3 At a convenient point during a reel oscillation, begin timing. Continue timing for 100 oscillations. The total divided by 100 equals T , the time for one oscillation. This measurement shall be made three times, the reel being removed each time. The three measurements shall be averaged.

4.11.3.4 Substitute the derived value into the following formula and calculate I :

$$I = AW(T^2 - B)$$

where

I = moment of inertia ($\text{in} \cdot \text{lb} \cdot \text{s}^2$)

A = 0.0467 inch

W = weight in pounds

T = period in seconds

B = 0.1885 s^2

4.12 Opacity

4.12.1 Definition. A characteristics that limits the transmission of light through the tape.

4.12.2 Requirement. The opacity of the tape shall not be less than 95% over the range of wavelengths given in 4.12.3.

4.12.3 Procedure. The tape shall be measured with a light source and detection system capable of working the complete range from 16 to $59 \mu\text{m}$. The effective opacity of a tape sample may be measured by obtaining the ratio of the detector resistance with and without a single layer of tape inserted in the measuring device.

4.13 Abrasivity

4.13.1 Definition. The tendency of a magnetic tape to abrade or wear a tape transport.

4.13.2 Recommendation. The allowable limits of wear and the procedures for measuring shall be negotiated between those requiring data interchange and the tape supplier. Guidelines for negotiations will be the specific requirements of the tape drive(s) in use by the interchange parties.

4.14 Inhibitor Tape

4.14.1 Definition. A tape that degrades performance of the tape transport such that unsatisfactory operation is experienced with the tape in question or with an otherwise satisfactory tape mounted on a transport in subsequent passes.

4.14.2 Requirements. The tape shall not be an inhibitor tape.

4.15 Media/Motion Interface

4.15.1 Definition. The consistency of the start/stop velocity profile.

4.15.2 Recommendation. The consistency of the interface (start/stop profile) between the media and the transport is a requirement for good operation. The allowable limits of the media/motion interface and the procedures for measuring shall be negotiated between those requiring data interchange and the tape supplier. Guide-

lines for negotiations will be the specific requirements of the tape drive(s) in use by the interchange parties.

4.16 Peel Adhesion.

4.16.1 Definition. The force required to peel coating from either surface of the tape.

4.16.2 Requirement. The peel adhesion shall be greater than 0.35 pound per 1/2 inch of tape width.

4.16.3 Procedure. Obtain a tape sample approximately 15 inches in length. Scribe a line through the coating across the width of the sample. Attach one end (approximately 5 inches long) to a smooth metal plate using a double-coated pressure-sensitive tape (Permacel P941, or the equivalent) between plate and the surface. Attach the metal plate and free end of the tape between jaws with an initial separation of approximately 10 inches such that when the jaws are separated the tape is peeled from the metal plate at an angle of 180 degrees beginning at the scribed line. Set the jaw separation rate at 10 inches per minute. Note and record the force required to peel the tape from the pressure-sensitive tape. An Instron Model TM-4, or the equivalent, may be used for this test.

4.17 Back Surface Reflectivity

4.17.1 Definition. The percent reflectivity of the back surface of the tape compared to a reference standard at an incident light angle of 60 degrees.

4.17.2 Requirement. The reflectivity of the back surface of the magnetic tape shall not exceed 30% of the reflectivity of the standard.

4.17.3 Procedure. Use the procedure and reflectivity standard specified in 3.3.2.3. Measure and note the reflectivity of the standard and the back surface under test. Compare the back surface reflectivity to the reflectivity of the standard.

4.18 Stiffness

4.18.1 Definition. The ability of tape to resist bending.

4.18.2 Requirement. The load scale reading should be between 14 and 32, measured at 20-degree angular deflection on a stiffness tester with a 0.005-inch-pound moment and a 0.125-inch $\pm$ 0.005-inch span length.

4.18.3 Procedure. Perform the test per American National Standard Method of Test for Stiffness of Plastics by Means of a Cantilever Beam, K65.13-1973 (ASTM D 747-70), excluding limitations on thickness of sample.

5. Tape Magnetic Requirements

5.1 Output

5.1.1 Definition. The output is defined as the aver-

age peak-to-peak value of the read voltage over at least 10 000 consecutive flux reversals.

5.1.2 Requirement. The output shall be within $\pm 10\%$ of the Standard Reference Amplitude at 200 and 800 CPI and within $+ 25\%$, $- 10\%$ at 3200 frpi (flux reversals per inch).

5.1.3 Procedure. The tape under test and the Amplitude Reference Tape shall be recorded on the same equipment with continuous ones at the bit density under test and at the Standard Measurement Current. The output level shall be measured on the center track on the read-while-write pass, using suitable output level measuring equipment. On equipment without the read-while-write capability, this measurement shall be made on the first forward read pass on the same equipment. The figure is expressed as a percentage of the Standard Reference Amplitude.

5.2 Dropout (Signal)

5.2.1 Definition. Any read signal that falls below the levels given in 5.2.1.1 and 5.2.1.2.

5.2.1.1 200 CPI, 800 CPI. A read signal having a peak amplitude less than 50% of the peak signal obtained from the Amplitude Reference Tape (SRM 3200).

5.2.1.2 3200 frpi. A read signal having a peak amplitude less than 35% of the peak signal obtained from the Amplitude Reference Tape (SRM 3200).

5.2.2 Recommendation. The number of rejected regions (not to exceed 0.4 inch per region) due to dropouts in an interchange environment is a matter of agreement between interchange parties. For purposes of evaluation of an unrecorded tape to be used for interchange, an average of one rejected region per 250 feet is the recommended maximum limit.

5.3 Drop-in (Noise)

5.3.1 Definition. The presence of any spurious tape signal, after full-width erasure, greater than 10% of the average read signal obtained from the Amplitude Reference Tape (SRM 3200) at the operating density.

5.3.2 Recommendation. There shall be no drop-ins allowed.

5.4 Ease of Erasure

5.4.1 Definition. The ability of a magnetic tape to have the recorded flux pattern decreased in amplitude below a specified level by the application of a specified magnetic field.

5.4.2 Requirement. The erased signal of a tape sample shall be less than 4% of the Standard Reference Amplitude at 3200 frpi.

5.4.3 Procedure

5.4.3.1 Record the Amplitude Reference Tape at 3200 frpi, Standard Measurement Current, all tracks. Record the peak signal output out of each read track.

5.4.3.2 Record the tape sample at 200 or 800 frpi, Standard Measurement Current, all tracks. Erase full width using a steady unidirectional horizontal field of 1000 oersteds.

5.4.3.3 Read the tape sample on the same device as in 5.4.3.1. Record the peak signal output out of each head track, ignoring drop-ins.

5.4.3.4 Express as a percentage the ratio of the peak signal output obtained in 5.4.3.3 to the corresponding peak signal output obtained in 5.4.3.1. This number shall comply with the requirement given in 5.4.2.

6. Tape Reel Requirements

6.1 Reels shall be constructed such that any profile section taken through the center axis of the reel conforms to Fig. 4, except where taken so as to pass through the relieved portion of the write-enable ring groove. The section shall, in this case, conform to the profile of Fig. 4 with appropriate deviations permitted at the ring-groove relief as illustrated in Section Z-Z of the figure.

6.2 Dimension L (see Fig. 4) defines the minimum diameter of the reel mounting surface. The ring-groove relief (see Fig. 4) is not required so long as the ring type designated for that reel does not protrude beyond the reel mounting surface.

6.3 All dimensions shown in Fig. 4, including those in detail sections, shall be held to the tolerances specified in Table 1.

6.4 The thickness of the flange portion of reels may be varied, but must fall entirely within the cross-hatched envelopes defined by dimensions J_f , J_r , K_f , K_r , and M.

6.5 Hub and flanges need not be integral, but may be separate parts at the manufacturer's option so long as no relative movement between the parts can occur in normal use and all other requirements of this standard are met.

6.6 Bosses, ribs, or raised designs are permitted on the outside surfaces of the flanges, provided that they do not extend beyond the crosshatched envelope of Fig. 4.

6.7 Flange holes are optional, as are their number, size, and shape when provided.

6.8 Reels may be constructed from any suitable material or materials so long as the dimensional and inertial requirements of this standard are maintained.

Table 1
Reel Dimensions

Dimension (See Fig. 4)	Tolerance*
A	3.688 ± 0.005 – 0.003
B†	10.500 ± 0.020
C	5.125 ± 0.005
D‡	3.875 ± 0.005
E‡	4.388 ± 0.005
F	0.250 ± 0.010 – 0.000
H	0.750 ± 0.015
J_f	0.622 ± 0.025 – 0.005
J_r	0.097 ± 0.005 – 0.025
K_f	0.125 max
K_r	0.080 max
L	4.125 min
M	0.718 ± 0.005
P	$4.00^\circ \pm 0.25^\circ$
R	1.677 ± 0.010

*Unless otherwise specified, all tolerances are in inches.

†Reels with a smaller B dimension are acceptable provided that agreement exists between interchange parties.

‡Diameters measured at the top of the groove.

6.9 Reels are not symmetrical, the flanges differing primarily as to the presence or absence of the write-enable ring groove.

6.10 The outside cylindrical surface of the hub shall be concentric with the bore (dimensions C and A, respectively, of Fig. 4) within 0.020 inch Total Indicator Reading (TIR).

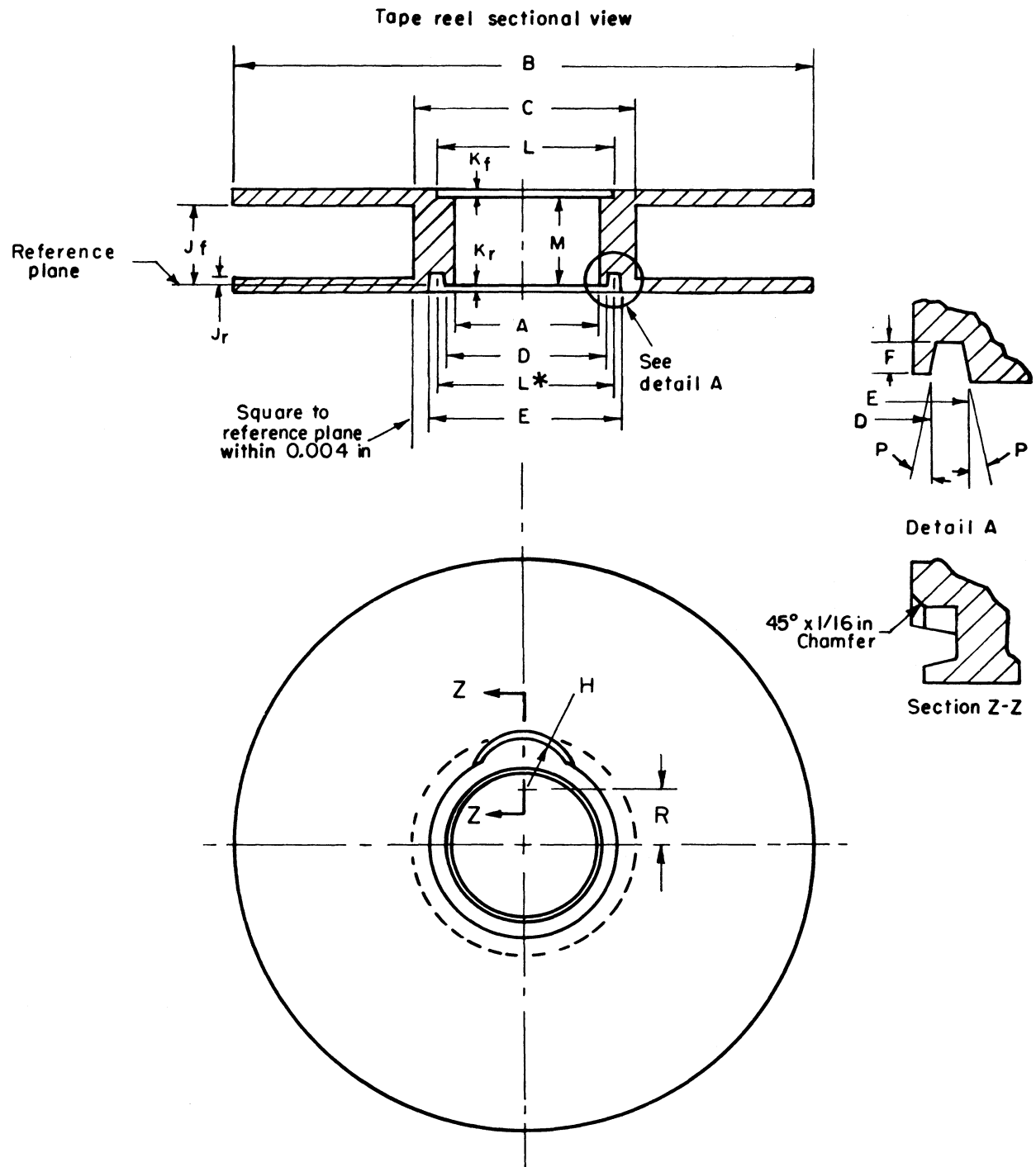
6.11 The write-enable ring groove walls (dimensions D and E of Fig. 4) shall be concentric with the center bore (dimension A of Fig. 4) within 0.020 inch TIR.

6.12 Dimension A shall not be less than 3.680 inches when the reel is fully loaded with tape wound at a constant tension of 12 ounces.

6.13 The moment of inertia of the empty reel shall not exceed $0.024 \text{ in} \cdot \text{lb} \cdot \text{s}^2$.

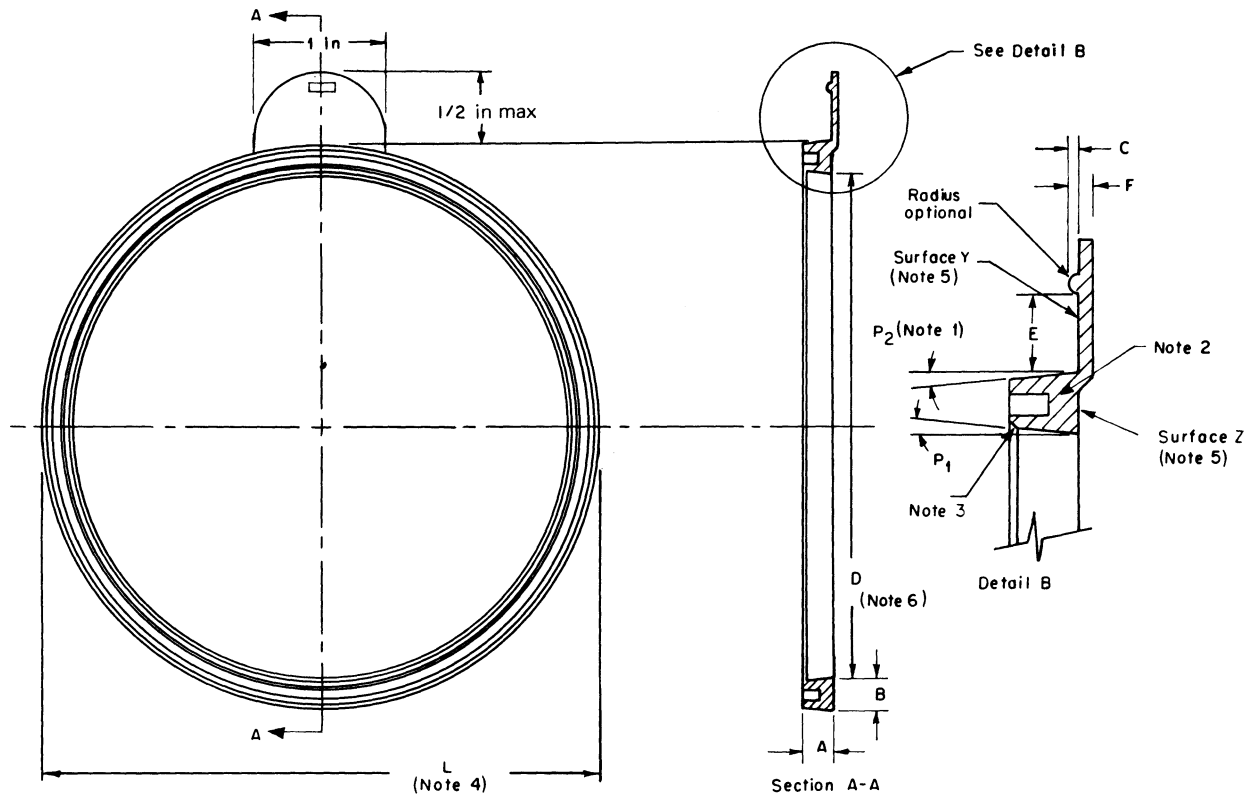
7. Write-Enable Ring (See Fig. 5)

7.1 When installed on a standard reel, the top surface of the write-enable ring shall be such that it does not protrude above the lateral mounting surface as defined by dimension L in Fig. 4.



*See 6.2.

Fig. 4
Tape Reel



NOTES:

- (1) Angle must be such that the outside diameter (OD) of ring does not interfere with ring groove when ring is installed.
- (2) Cross section optional within dimensions specified.
- (3) Edge relief optional: 1/32 inch $\times$ 45 degree chamfer, or 1/16 inch R.
- (4) L dimension is measured with ring installed in a standard reel.
- (5) Surface Y must not be recessed below the plane of surface Z.
- (6) For D see 7.3.

Fig. 5
Write-Enable Ring

Table 2
Write-Enable Ring Dimensions

Dimension	Tolerance*
A	0.235 + 0.010 - 0.020
B	0.230 ± 0.010
C	0.040 max
E	0.300 min
F	0.060 max
L	4.383 max
P ₁	4° ± 1°
P ₂	3° min

*Unless otherwise specified, all tolerances are in inches.

7.2 All rings shall have a tab to facilitate removal from the groove. The shape and size of the tab are optional within the limits specified.

7.3 The D dimension, cross section, and material used shall be such that the ring may be installed and removed with reasonable effort and will remain seated during normal use.

7.4 Dimensions and tolerances are given in Table 2.

8. Revision of American National Standards Referred to in This Document

When the following American National Standards referred to in this document are superseded by a revision approved by the American National Standards Institute, Inc, the revision shall apply:

American National Standard Method of Test for Stiffness of Plastics by Means of a Cantilever Beam, K65.13-1973 (ASTM D 747-70)

American National Standard Code for Information Interchange, X3.4-1968 (ASCII)

American National Standard Recorded Magnetic Tape for Information Interchange (200 CPI, NRZI), X3.14-1973

American National Standard Recorded Magnetic Tape for Information Interchange (800 CPI, NRZI), X3.22-1973

American National Standard Recorded Magnetic Tape for Information Interchange (1600 CPI, PE), X3.39-1973

Appendix

(This Appendix is not a part of American National Standard Unrecorded Magnetic Tape for Information Interchange (9-Track 200 and 800 CPI, NRZI, and 1600 CPI, PE), X3.40-1976, but is included for information purposes only.)

Design Considerations

A1. Introduction

This unrecorded magnetic tape standard is intended for use in conjunction with American National Standards on recorded magnetic tape for information interchange. The recorded standards cover 9-track 200 CPI, NRZI; 9-track 800 CPI, NRZI; and 9-track 1600 CPI, PE recording techniques.

A2. Specification Support

A2.1 General Definitions (See Section 2). Since output-versus-write current curves have varying shapes, as well as varying rates of curvature, which preclude an accurate, definable "saturation current" point, this specification uses a point on a saturation curve that is 5% below the maximum output to establish a reference current (I_r) point. The Standard Measurement Current (I_m) is defined as being a recording current n times higher than the reference current. The specified value of n varies with density. (See Fig. A1.)

A2.2 Ease of Erasure (See 5.4.3). For the measurement of ease of erasure, it is assumed that transport system noise is minimized, or that such noise is a known quantity that is taken into consideration, or that both these conditions are met.

A2.3 Environment (See 3.2). The requirements here are not to be construed as an endorsement for rapid temperature changes. When rapid excursions are made, it is recommended that a rewind pass be made (at users' discretion) possibly to preclude future cinching or other mechanical problems during rapid starts and stops.

A2.4 Usable Recording Area. Reference is made to "usable recording area" in Fig. 1. It is intended that interchange tapes meet all applicable requirements of this standard in the area designated as "usable recording area."

This does not imply that all tapes to be used for interchange must be individually tested for compliance with each separate requirement. It is the responsibility of the manufacturer of tapes and subsequently of the interchange parties to determine the extent and fre-

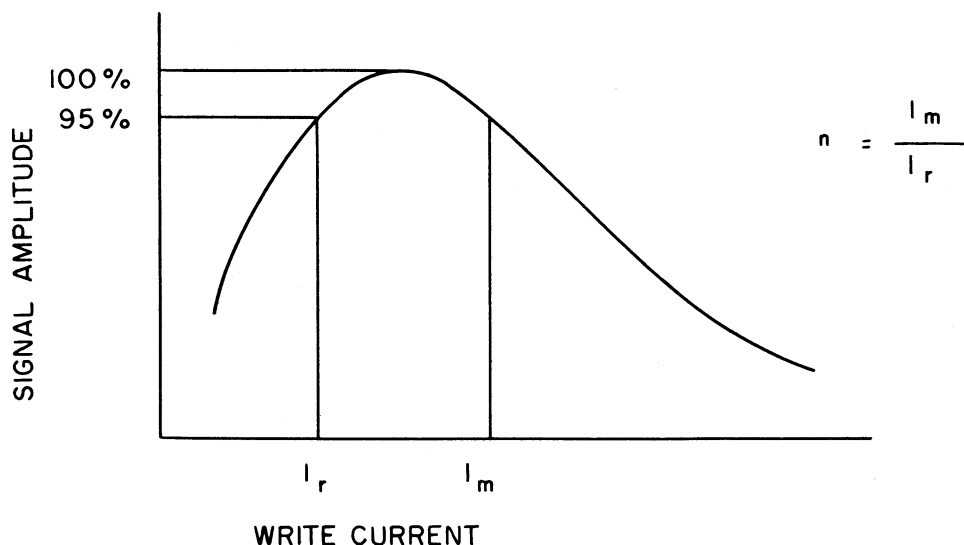


Fig. A1
Saturation Curve

quency of testing necessary to ensure compliance of the "usable recording area" to this standard during manufacture.

A2.5 Abrasivity (See 4.13). Head wear is one of the prevalent and expensive component problems associated with abrasivity. The useful life of a magnetic head bears a direct relationship to many interrelated factors such as type of head, transport type, tape velocity, tolerances, and abrasivity of tape. This life may range from 100 hours to several thousand hours, with the final limitation being imposed by the abrasive characteristics of the magnetic tape that contacts the head. The cost of head replacement alone is significant enough to warrant user concern. When one considers the other factors, such as constantly changing head characteristics and the possibility of damaging tapes and subsequent loss of data due to changing head conditions, it is essential that the user be made aware of the abrasion characteristics of magnetic computer tapes, and their impact on maintenance and replacement of component parts. A similar rationale applies to capstans, tape guides, and other tape path components.

A2.6 Rubber Curing Cycle (See 4.5.4). The curing cycle involves the following:

- (1) Boil in 2% solution (by weight) of tannic acid and distilled water for 45 minutes.
- (2) Rinse in distilled water.
- (3) Dry at 115°C for 45 minutes.

Vulcanized layer is to be concentric to center bore of steel cylinder within 0.001 inch and square to cylinder base within 0.001 inch. Prior to testing, the rubber surface should be cleaned with 1,1,1-trichloroethane and allowed to dry at least 4 hours.

A2.7 Dropouts (Signal) and Drop-ins (Noise). It was felt reasonable that dropouts and drop-ins could be defined in an unrecorded environment. The tolerances and number of dropouts were selected to provide a guide to the user.

A2.7.1 New and used tapes are covered by this stan-

dard. The size and quantity of defects of a used tape will depend on the previous history of the tape.

A2.7.2 The limits on numbers of defects are not an absolute requirement for interchange, since machine and programming concepts allow a varying number of defects. However, the reliability of interchange is enhanced by using tapes that contain a minimum number of defects.

A2.8 Marker Placement (See 3.3). If marker placements other than those given in the standard are used, it must be done with the understanding of the interchange parties.

A2.9 Back Surface Electrical Resistance. It was felt that it was not necessary to define or restrict the electrical resistance of the back surface for data interchange as long as the electrical resistance of the oxide surface was maintained within the limits specified in 4.10.2.

A2.10 Friction. The dynamic friction and static frictional forces between the back surface of magnetic tapes and metal and rubber surfaces were investigated with the intent of more clearly defining these characteristics. The investigation of dynamic friction using a Bell Laboratories Frictionometer revealed that the dynamic friction of back-coated tapes to metal was higher than non-back-coated tapes. However, the relationship between the values measured and interchange of data could not be specified.

The coefficients of static friction between the back surface of the tape and various rubber capstans were compared using an Instron tensile tester. The relative difference between back-coated and non-back-coated tapes was insignificant compared to the differences noted between the various capstans evaluated.

A2.11 Inhibitor Tape. Physical or chemical interference between tapes may render one tape to be an inhibitor to the successful operation of another. Increased requirements to clean a drive may indicate the presence of an inhibitor tape.

American National Standards on Computers and Information Processing

- X3.1-1969** Synchronous Signaling Rates for Data Transmission
- X3.2-1970** Print Specifications for Magnetic Ink Character Recognition
- X3.3-1970** Bank Check Specifications for Magnetic Ink Character Recognition
- X3.4-1968** Code for Information Interchange
- X3.5-1970** Flowchart Symbols and Their Usage in Information Processing
- X3.6-1965 (R1973)** Perforated Tape Code for Information Interchange
- X3.9-1966** FORTRAN
- X3.10-1966** Basic FORTRAN
- X3.11-1969** Specification for General Purpose Paper Cards for Information Processing
- X3.12-1970** Vocabulary for Information Processing
- X3.14-1973** Recorded Magnetic Tape for Information Interchange (200 CPI, NRZI)
- X3.15-1966** Bit Sequencing of the American National Standard Code for Information Interchange in Serial-by-Bit Data Transmission
- X3.16-1966** Character Structure and Character Parity Sense for Serial-by-Bit Data Communication in the American National Standard Code for Information Interchange
- X3.17-1974** Character Set and Print Quality for Optical Character Recognition (OCR-A)
- X3.18-1974** One-Inch Perforated Paper Tape for Information Interchange
- X3.19-1974** Eleven-Sixteenths-Inch Perforated Paper Tape for Information Interchange
- X3.20-1967 (R1974)** Take-Up Reels for One-Inch Perforated Tape for Information Interchange
- X3.21-1967** Rectangular Holes in Twelve-Row Punched Cards
- X3.22-1973** Recorded Magnetic Tape for Information Interchange (800 CPI, NRZI)
- X3.23-1974** Programming Language COBOL
- X3.24-1968** Signal Quality at Interface between Data Processing Terminal Equipment and Synchronous Data Communication Equipment for Serial Data Transmission
- X3.25-1968** Character Structure and Character Parity Sense for Parallel-by-Bit Communication in the American National Standard Code for Information Interchange
- X3.26-1970** Hollerith Punched Card Code
- X3.27-1969** Magnetic Tape Labels for Information Interchange
- X3.28-1976** Procedures for the Use of the Communication Control Characters of American National Standard Code for Information Interchange in Specified Data Communication Links
- X3.29-1971** Specifications for Properties of Unpunched Oiled Paper Perforator Tape
- X3.30-1971** Representation for Calendar Date and Ordinal Date for Information Interchange
- X3.31-1973** Structure for the Identification of the Counties of the United States for Information Interchange
- X3.32-1973** Graphic Representation of the Control Characters of American National Standard Code for Information Interchange
- X3.34-1972** Interchange Rolls of Perforated Tape for Information Interchange
- X3.36-1975** Synchronous High-Speed Data Signaling Rates between Data Terminal Equipment and Data Communication Equipment
- X3.37-1974** Programming Language APT
- X3.38-1972** Identification of States of the United States (Including the District of Columbia) for Information Interchange
- X3.39-1973** Recorded Magnetic Tape for Information Interchange (1600 CPI, PE)
- X3.40-1976** Unrecorded Magnetic Tape for Information Interchange (9-Track 200 and 800 CPI, NRZI, and 1600 CPI, PE)
- X3.41-1974** Code Extension Techniques for Use with the 7-Bit Coded Character Set of American National Standard Code for Information Interchange
- X3.42-1975** Representation of Numeric Values in Character Strings for Information Interchange
- X3.44-1974** Determination of the Performance of Data Communication Systems
- X3.45-1974** Character Set for Handprinting
- X3.46-1974** Unrecorded Magnetic Six-Disk Pack (General, Physical, and Magnetic Characteristics)
- X3.49-1975** Character Set for Optical Character Recognition (OCR-B)
- X3.50-1976** Representations for U.S. Customary, SI, and Other Units to Be Used in Systems with Limited Character Sets
- X3.51-1975** Representations of Universal Time, Local Time Differentials, and United States Time Zone References for Information Interchange
- X3.52-1976** Unrecorded Single-Disk Cartridge (Front Loading, 2200 BPI), General, Physical, and Magnetic Requirements

For a free and complete list of all American National Standards, write:

American National Standards Institute, Inc
1430 Broadway
New York, N.Y. 10018